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AUTHOR Urban, Edward F.
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ABSTRACT

This document contains information, based on the instructional systems design model, about the development and delivery of a 10-minute video training program to teach college engineering technology students how to use a micrometer to measure to one thousandth of an inch. The students were taught the following: (1) to identify the parts of the micrometer; (2) the terminology associated with a micrometer; and (3) to read a micrometer. During the analysis portion of the project, an audience needs analysis was conducted; space and time constraints were evaluated; the number of trainees was set; the medium was selected; instructional goals were determined; a budget was prepared; and a project timeline was developed. During the design portion of the project, an instructional task analysis was performed; instructional objectives were developed; entry behaviors were defined; learning activities were sequenced; and evaluation was specified. During the development phase of the project, the video and printed handouts were developed, based on Gagne's nine events of instruction. After implementation, students completed a posttest and questionnaire, which assessed their reactions to the program and determined whether or not they had met the learning objectives. (The document includes a 23-item bibliography and appendices that contain audience analysis forms, a needs survey instrument, an instructional analysis form for scale reading, project planning forms, printed handouts, posttests, and the video script.) (CML)

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THE SCHOOL OF MEDIA AND ARTS

of

NEW YORK INSTITUTE OF TECHNOLOGY

announces the

Final Examination

of

Edward F. Urban

for the degree of

MASTER OF SCIENCE

in

TRAINING AND LEARNING TECHNOLOGY

A Basic Measuring Instrumentation Training Program for New York Institute of Technology

Abstract

This is a report and examination of the analysis, design, development, implementation, and evaluation of a Instructional Training Module.

A video was provided to instruct undergraduate students on the use of the micrometer in the Engineering Technology curriculum at the New York Institute of Technology. Based on the formative evaluation techniques conducted at N.Y.I.T., the instructional materials were improved. They were ultimately successful.

In future delivery of the instruction the designer recommends the addition of acronyms for identifying the various parts of a micrometer. The design of this module could be expanded in areas where accurate measuring instrumentation is utilized.

Friday, May 30, 1989 at 10:30 a.m.

in

Conference Room, French Chateau
Old Westbury Campus
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A BASIC MEASURING INSTRUMENTATION TRAINING PROGRAM FOR NEW YORK INSTITUTE OF TECHNOLOGY

a

THESIS/PROJECT

by

EDWARD F. URBAN

submitted to the faculty of the
School of Media and Arts

of

NEW YORK INSTITUTE OF TECHNOLOGY

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

TRAINING AND LEARNING TECHNOLOGY

MAY 30, 1989

Approved _____
Anthony Piazza - Examiner

Approved _____
David Yens, Ph.D. - Examiner

Approved _____
Noreen Lowey - Examiner

Approved _____
Leslie Horowitz, Ed.D. - Examiner

Approved _____
Angus Reynolds, Ed.D. - Associate Dean
Graduate Programs in Training and
Learning Technology

Approved _____
Adrienne O'Brien, Ph.D. - Dean
School of Media and Arts

A BASIC MEASURING INSTRUMENTATION TRAINING PROGRAM FOR NEW YORK INSTITUTE OF TECHNOLOGY

by

Edward F. Urban

B.S. 1985, NEW YORK INSTITUTE OF TECHNOLOGY

A Thesis/Project

submitted to the Faculty of the

School of Media and Arts

of the New York Institute of Technology in partial satisfaction of the requirements for the degree of

Master of Science

June 11, 1989

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The author wishes to express his thanks to the individuals who, through their dedication, patience, and hard work, helped make this document possible.

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CHAPTER 1

INTRODUCTION

Overview

This document contains all the pertinent information for the development and the delivery of a training plan on measuring instrumentation for New York Institute of Technology. The instructional design presented here focuses on a program that will produce the most outstanding engineering and technology students in the world while retaining students. The entire document is based on the Instructional Design process. All procedures, instructional material, and evaluation results are contained within this systematic design of instruction.

Background

The application of measuring principles in mass production has lead to major improvements in quality control. This is largely attributed to close tolerances that must be maintained in order to turn out parts that are interchangeable. For mass production to be successful, any one of a large quantity of parts must fit together.

Determination of linear measurements is one of the most fundamental measurements of all. In unit form they may be either a measurement of strain or a measurement of angular displacement. Displacement lends itself to the simplest

process of measurement. The measurements contained in this instructional design module are based on standard industrial measurements traceable to the International Board of Standards in Sever, France.

Presently, international competition is forcing companies to build parts with accuracies up to one thousandths of an inch. Without this type of accuracy the competition will slowly gain a greater market share. If a company is to remain competitive, the accuracy in which parts are measured must be optimized.

The video training program presented here is focused on the specific skills that are needed for effective measurement techniques. It is designed to allow the trainees to participate while encouraging a sense of accomplishment.

The micrometer is a specific displacement measuring device used to obtain measurements that reflect a resolution up to ten thousandths of an inch (depending upon the type of micrometer). It is viewed as an important instrument needed to accomplish a simple task that could otherwise be very tedious.

Statement of the Problem

One of the most important phases in colleges, vocational schools, technical institutes, and apprentice schools within industry in the United States has been the need to train people in the use of accurate instrumentation. In many

industries the proper application of basic instrumentation can often be tedious and difficult to master.

Three specific aspects of educational psychology have emerged in recent years. Each pertains to the hurdles a trainer must face in order to overcome the barriers that resist the fundamental understanding of education namely:

1. Intelligibility of the learner
2. Individual differences
3. Educational technology

Unfortunately, knowing how to eliminate barriers and actually overcoming these obstacles can often be difficult. Many of the barriers can be overcome through initiating accurate interpersonal communication between the designer and the trainee. It's important that when the trainer sends a message that the same message is interpreted by the receiver. If the correct message has been received, meaningful and accurate interpersonal communication have taken place.

Various skills come into play when a trainer begins the planning of a lesson, for example, the education of different trainees, the degree to which the trainees are ready to learn, and naturally the rate at which the trainee is ready to learn, all play a vital role in education. The skills and achievement levels of particular groups of learners are rarely homogeneous. If trainers are to maximize the effectiveness of a lesson plan, the importance of different

assignments must be recognized. This will allow trainees to proceed at their own pace. Many psychologists such as Montessori and Piaget feel that it is critical to direct individuals in exercises which are self directing and self rewarding. This becomes particularly important in training adults.

Measuring correctly once gives an individual a feeling of satisfaction. This satisfied need is a desired function in training this target audience. the audience is a group of sophomore college students enrolled at New York Institute of Technology (NYIT).

In the Fall of 1986 the Engineering Technology department at New York Institute of Technology began to train a group of sophomore students in a course known as "Physical Measurements and Analysis." The course was geared towards a group of first semester sophomore students.

Many of the students had come together due to the requirements of their curriculum. Since this course was also required for the Electrical/Mechanical Technology department, each of the two groups of students had its own interests. This meant that the lesson plan had to be centered around electrical instrumentation as well as mechanical instrumentation. Comparing the content of the courses that each student would be required to take, and the future of their employment opportunities, it can be seen that a gap exists which needs to be fulfilled.

To further complicate matters, there now exists a situation where students are out of sequence. This means that the trainees could be either Freshmen, Sophomores, Juniors, or Seniors. It was evident that an effective instrumentation module was needed that could fit the needs of all the students.

The course content of this project centers on three areas namely:

1. The terminology often used with a micrometer.
2. The various pieces that make up a micrometer.
3. How to read a micrometer.

Purpose of the Project

The purpose of this project is to train a varied group of college engineering technology students to measure accurately using a micrometer. The designer developed a training program which focused on the identification of measuring instrumentation. The intention was to analyze, design, develop, and evaluate a training program that would enable college students to develop a sense of measuring skills. The interests of the target audience are motivated by the information or benefits received once the lesson plan is completed.

Definition of Terms

Certain terms in this document are capitalized. While this practice may not conform to current rules of grammar, the form chosen is a courtesy to the reader. The terms or words which appear in this paper are the following:

Jaw, Thimble, Ratchet - Parts that make up a micrometer.

Thousandths - Measurements carried out to three decimal places.

Hundredths - Measurements carried out to two decimal places.

Tenths - Measurements carried out to one decimal place.

Basic Dimension - A theoretical (desired) feature location, shape, size.

Decimal-inch system - System of linear measurement based on decimal division of the inch.

Diameter - The length of chord passing through the center of a circle.

Dimension - Any measurable extent, such as length, width, thickness.

Measurement - The determination of a dimension of a part through the use of some type of instrument that permits the magnitude of the dimension to be determined, either directly or indirectly, in terms of scalar units.

Parallax Error - Error in reading an instrument employing a scale and pointer, because the observer's eye and pointer are not in a line perpendicular to the plane of the

scale.

Repeatability - The variation along various measurements taken with one instrument on one part. A measure of precision not accuracy.

Scale - The graduations on a rule or other graduated measurement instrument.

Unit of length - Unit of length recognized as a standard of length.

SIE - Abbreviation for the "Statistics of Instrument Error."

Assumptions

1. That trainees in the engineering curriculum are highly motivated.

2. That NYIT engineering students throughout their educational process need a concept of accurate measurement techniques.

Limitations

1. That this project was developed at the New York Institute of Technology as part of an in-house training program. The initial training was developed as part of a measurement program for error analysis. Its content may not be suitable for other countries without modifications.

Method and Procedures

The methods chosen in this training plan are based on an Instructional Systems Design module. This development

process is described by Gropper and Ross in Dick and Carey (1985) and in Craig (1987). Each source describes five similar areas based on the Instructional Systems Design process or (ISD) Model. The segments referenced in this document pay particular attention to the analysis, design, development, implementation, and evaluation process.

Analysis

Initially, the designer was faced with the collection of data. Through extensive research the designer decided that there were three major job tasks that needed to be performed in order to complete the lesson successfully. This consisted of facts, principles, and skills.

The designer chose to gather information through questionnaires and the use of an audience analysis survey. Each of the forms was designed to point out the strengths and weaknesses of the participants. See Appendix A.

Design

The designer studied methods for the delivery of the lesson plan, and decided that the most efficient form of delivery would be through the use of a video tape. The video tape was chosen when it was determined that the measuring instrumentation being used needed to be viewed by the trainees.

Once the tasks were determined, the next step was to develop the learning objectives. According to Mager (1986) each of the objectives has three parts:

1. Performance - What the trainee will demonstrate.
2. Conditions - What conditions will be present while the trainee performs.
3. Criteria - What the trainees are expected to do or say in order to successfully complete the program.

Development

The designer developed the training plan based on the guidelines described by Heinich, Molenda, and Russell (1982). 5). The methods of instruction are delivered through the use of a video presentation. The presentation consisted of visuals obtained from the Henry Ford Trade School (1955).

Implementation

To make the training content relevant, the designer first developed a strategy that coincides with the trainees work patterns. This was conducted through the use of one-on-one interviews. Then by listening, observing, and responding to a set of questions, data were collected and arrangements were made for a pilot test.

Evaluation

Two field tests were conducted which had a direct bearing on the formative evaluation. The formative evaluation resulted in a new script, room size, visibility of video screen, and with an improved quality of visual training aids.

Summary

Because of the numerous courses trainees will be

expected to take, the accuracy in which trainees utilize their measurement techniques will be of primary importance. The determination of linear measurement is extremely important in developing skills that apply to all areas of instrumentation. The training plan developed here is focused on strengthening both intellectual and psychomotor coordination. Much of the results in this document have been thoroughly examined and updated by information gathered from field surveys. The video presentation presented here on micrometers is expected to enhance the delivery of the content where learning skills require repeated observation.

Chapter 2

ANALYSIS

Introduction

The first step in the Instructional System Design process begins with the analysis of the target population. The instructional goal is analyzed to identify the subordinate skills necessary to operate a micrometer. This involves an in-depth investigation of the trainees that you are trying to change, and any applicable learning theories that help identify the trainees' need. This section of the instructional design serves as a building block for the remainder of this lesson plan.

Needs Analysis

The needs of the target audience were identified by evaluating the gap between current and expected skill levels. The needs of the target audience are described later in this chapter, and arrived at from the following:

1. a survey of existing measurement courses derived from articles of other universities,
2. brainstorming conducted with other faculty members,
3. demands of industry, and
4. knowledge trainees will need to successfully complete their expected needs.

Before any discussion of Statistics of Instrument Error (SIE) can be initiated, we need to answer the question, "What is a reliable measurement?" No matter how you answer

this question, a reliable measurement is a measurement in which the probability of error is small. This can be stated positively as an improvement yield or simply a correct measurement taken with precision.

Prior to developing this SIE course, many types of measuring instruments were already being used for determining linear measurements. A preliminary survey revealed that a new updated course would have to eventually evolve around electronic processing instrumentation. Therefore, this Introductory Design course now needed to be structured with the end product in mind.

The designer observed the type of facilities used. Then by visiting the class that was presently being conducted, the designer was then able to analyze a data collection format. In this case the designer had decided to collect data from non-reactive methods such as school records, the curriculum format in addition to other qualitative methods. Data was then tabulated as follows:

1) Mathematics courses completed
2) Knowledge of statistics
3) College level completed
4) Use of micrometer or other displacement measuring equipment accurate to one thousandths of an inch
5) Physically handicapped

Many of these questions and visits to the classroom were conducted to reveal the collection of data as well as

relevant facts. Each of the skills was carefully analyzed along with the type of equipment. Funding was then reviewed to meet the budget requirements.

The responses from five trainees who participated in the needs survey were tabulated. All questions were conducted informally by the designer with the results displayed in Appendix B.

The objective of this module is to improve the quality of measurements taken by the trainee. It will, therefore, be necessary to provide the right people with the right tools at the right time in order to facilitate the necessary changes. The right people will be a group of sophomore engineering students. The right tools are identified in Appendix C. The right time is just before the SIE program is about to begin.

The success of any program is directly related to the extent in which top management supports its implementation. To this day top management must be aware of the importance of technical improvements and support the changing objectives. This initial step set forth by management is critical in the development of any training plan.

Job Task Analysis

A job task analysis is extremely important in differentiating skills that are needed at different management levels. The measurement techniques learned here will be applicable for the inspection of parts. The trainees

will be responsible for each measurement process.

The job task analysis must first start with the activities that are critical for the targeted job. The trainees will be aware of the fact that their education and experience in the identification of problem sources begin with accurate measurement. Lord Kelvin once said, "When you measure what you are speaking about and express it in numbers, you know something about it; and when you cannot measure it, you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely in your thought advanced to the stage of science" (National Tooling and Machining Association, 1981).

Many of the tasks employed are associated with the common scale displayed in Appendix D. The measurement capability of the trainees will be upgraded to increase their measurement skills to thousandths of an inch. The second and third phase of this program is then used to develop the statistics of instrument error.

Target Population Analysis

The standards that are required for this module consist of mathematical skills. The mathematical standards in all cases should be sufficient due to the entry behavior required by most colleges. However, the gap in the application of these skills to instrumentation must be fulfilled.

The target audience identified is a group of sophomore

engineering / technology students. All of these students are assumed to have an accredited high school certificate. Each is involved in a 16-week program in which 3 sessions are allocated toward the development of specific measuring skills. The students should be a group of sophomores but could be entering into this course as:

1) Freshmen
2) Sophomores
3) Juniors
4) Seniors

Some of the students have had previous experience as a machinist prior to entering college while others had no related job experience. Looking at the qualifications of my target audience and relating unit, a comparison can then be analyzed.

Organizational Constraints

Organizational constraints vary for each training module because of the media that is selected and the availability of resources. The designer was assigned a classroom for the span of 2.5 hours a day, two days a week in which the training plan could be presented. Upon viewing the number of trainees and the space available, a video presentation was chosen to deliver the lesson plan. A learning activity package was also considered but the budget and the time frame would have made this unacceptable. A learning activity

package was also inappropriate because of the nature of the lesson plan. Psychomotor skills that needed to be addressed would have been difficult to attain. After viewing the size of the classroom, it was decided upon by the designer to limit the number of trainees to 15. Any additional trainees would require additional space and equipment.

The room assigned to this course consisted of eight work benches. Each bench was to accommodate approximately two trainees. Unfortunately, the size of the work benches made it extremely difficult for them to sit in the preferred circular formation. This problem would then have to be offset by other variables that effect the visual presentation.

Heinich, Molenda, and Russell (1982) stated that video tapes have a distinctive advantage over other forms of media where psychomotor skills are involved. Research has shown that video tapes and films alike are particularly useful in the delivery of content where learning skills require repeated observation.

In developing the instructional strategy the designer identified three job tasks that would allow trainees to master the use of a micrometer.

1) Measurement terminology
2) Psychomotor skills
3) Equipment terminology

Trainees enrolled in this program will gain experience

with a variety of measuring scales. Each of the scales is then associated with the scale on a micrometer. By measuring test pieces at the end of the video presentation, trainees are then required to repeat the measurements obtained. The resolution obtained will be within ten thousandths of an inch. The dimensions are always related to some absolute zero point.

In the English system the standard unit of measurement is the inch. The inch is then broken down into smaller divisions for finer measurements. Fractions of an inch can be broken down into equally spaced lines. For example, 1/2 inch, 1/8 inch, 1/16 inch. The decimal can also be referenced as decimal fractions such as 1/10 inch, 1/100 inch, 1/1000 inch, 1/10000 inch. Scales associated with the micrometer commonly refer to decimal fractions. The typical measurement terminology often associated with these measurements are shown below.

one-tenth = .1

one-hundredth = .01

one-thousandth = .001

one ten-thousandth = .0001

When dealing with measurements in the English system, people often refer to decimal parts of the inch in terms of "thousandths." One tenth of an inch (1/10) is very often associated with one hundred thousandths of an inch. Measurement terminology is one of the steps that is

emphasized in the video presentation plan.

Psychomotor skills will be required for holding the micrometer and the object to be measured. The accuracy is then determined by repetition. Through repeated measurement exercises, trainees will gradually develop a feel for the micrometer.

The names of the pieces that make up a micrometer will be important for the delivery of this lesson plan. Without knowing the individual components, it would be very difficult to reference or describe steps needed to complete this lesson plan.

Instructional Goal

Students will demonstrate an ability to measure with a micrometer to one thousandths of an inch. They will also be expected to familiarize themselves with the parts that make up a micrometer through teach and tell routines. The measurement terminology is expected to be transferred to the trainees by association of scales similar to that of a rule. This instructional goal is classified as cognitive (Dick and Carey, 1985).

In a brainstorming session assembled by the director of the department for engineering technology, a discussion of the course content was assessed. There were five professors present and each presented topics on what they viewed as important. The results consisted of a new curriculum format. One of the topics discussed was measurement instrumentation.

In analyzing the stated instructional goal, it was clear that students had no experience in error analysis. A list of criteria was then developed to reach this goal. The outcome was the development of a module called "The Statistics of Instrument Error."

The task force reviewed and revised the instructional goal and presented it to the other faculty members. This was reviewed to determine if the revisions that were made reflected the desired goal.

The instruction content was agreed upon. Some of the considerations that were made in this analysis were as follows:

1) The amount of time needed to reach the desired skill.

2) The type of behavior needed to achieve the desired outcome.

3) The expertise of those in charge of developing the course.

4) The validity of the lesson plan in the foreseeable future.

The goal as it was presented had to be broken down into smaller units of instruction. The unit developed and discussed within this document is the first of a three-part series.

The criteria discussed above were all met except for the types of behavior that were needed to successfully complete the instructional goal. The implied skills were then analyzed to determine a sequence of events. Three levels of separate goals were decided upon. They are as follows:

1) How to read a micrometer.

2) Terminology associated with a micrometer.

3) Identify the various parts of a micrometer.

In reviewing the behavioral objectives the designer decided to sequence them to a video presentation. The designer decided the logical order was to identify the parts of the micrometer and associate the terms as a second part of the sequential order. The order was chosen referencing Bloom's Taxonomy of Objectives, 1955. The designer also felt that the terminology could familiarize the viewer with reading the micrometer. The methodology for deriving the courses is given by Dick and Carey, 1984.

Literature, Existing Course, and Material Review

The designer searched for literature in four distinctive areas as follows:

1) Manufacturing and tool operations

2) Theories of learning using new technologies of instructional media

3) Mathematics review books

4) Periodicals on technical training

Related Theory

James Gardner's (1981) major thesis in a book titled, Training Interventions in Job Skill Development emphasized training interventions as the key to success. Gardner believes that training interventions are geared to the

learning process and should occur progressively and differently in terms of appropriate approaches as the trainee advances through the learning stage. Trainers who do not see a need for progressive interventions, or who are reconciled to showing a trainee into a job method of sorts and letting "experience take its course " are incapable of bringing efficiency into the learning process. Unguided experience is not a good teacher.

The intention of Gardner is to discuss training interventions at various points in the skill development cycle. Each of the stages is listed in Gardner, 1981.

1) Mastery of perceptual steps and gross manipulation that represents an approximation of task execution.

2) Refinement of the task execution, involving the elimination of certain ineffective motions, a gain in speed of productive moves, and an efficiency of feedback.

3) Speed of task execution, as the refinements and precision related to the motions and feedback improve.

4) Organization of the job if several tasks are to be performed and there are conflicting demands on the employee's time.

5) Coping with unusual conditions.

Many of the procedural steps listed in Gardner's skill development cycle are pegged to the trainee's learning needs.

Eitington (1985) in his book titled, Instrumentation - A Tool For Self-Discovery Learning, also feels that interventions help facilitate learning in a structured way. Robert Blake and Jane Mouton of Managerial Grid, famed

pioneers in the field of instrumentation state, "a learning instrument may be the most important discovery in education since programed learning" (1971). It seems that Eitington uses instrumentation for live action learning. This consists of involvement, realism, introspection, attitude, and behavioral changes.

Based on Bloom's taxonomy, this project was classified as being in the cognitive domain of taxonomy illustrated in Table 1.

Table 1

The Cognitive Domain Taxonomy

Knowledge
Recall of specifics and universals
Recall of methods and processes
Recall of pattern, structure, or setting
Intellectual Abilities and Skills
Organized modes of operation
Generalized techniques dealing with materials and problems
Comprehension
Translation
Interpretation
Extrapolation
Application
General ideas, rules of procedures, or generalized methods
Analysis
Analysis of elements
Analysis of relationships
Analysis of organizational principals
Synthesis
Production of unique communication
Production of a plan, or proposed set of operations
Derivation of a set of abstract relations
Evaluation
Judgements in terms of Internal Evidence
Judgement in Terms of External Criteria

The information presented in this report is classified in the cognitive domain because of the type of

instrumentation and media that were selected. The cognitive domain consists of knowledge, intellectual abilities, and skills. The categories are then broken down into subcategories. It is hoped that the video being designed will actively involve the trainees by implementing some of these approaches.

Literature Review

A literature search was conducted at NYIT library using Dialogue Information Systems Inc. The search produced a computer based bibliography on information abstracts. The designer searched for information on training guides that produced 45,495 items. In cross-referencing this information with "measurement equipment" or "instrumentation with tools," the information was reduced to 1,115 items. In combining both, the results were reduced to 92 items. A final search for higher education or college training courses used in conjunction with the combination of the other items resulted in 21 items.

In reviewing the abstracts, vast amount of information contained edited documentation pertaining to technical training courses. An example of some of the information extracted from these articles is listed below.

1. A New Trend: Training on the "tube" (Maugh, T., 1985).

This is an article that provides efficient learning about training methods that incorporated instructional video cassettes. Advantages of this type of training plan

consisted of a step by step approach to instruction. Many of the current programs available are discussed and compared for context and style.

2. Self-Evaluation Instrumentation for Instructional Supervisors (Canizaro, B., 1985).

This article explains the skills, understanding, and attitudes necessary for an effective instructional administrative supervisor. This article refers to areas which supervisors can evaluate, describe, and analyze their instructional material. The self-evaluation techniques are geared toward new instructors or staff development programs. The questionnaires were based on personal behavior and content within the lesson plan. Corrective steps were then taken to improve the lesson plan.

3. How To Use a Tape Rule. General Metals I, Lesson Plan (Floyd,H., 1986).

The author of this article identifies four distinctive areas on which this lesson plan is based.

a. The parts of a tape rule

b. Determines the task for a certain size rule

c. Measurement capability

d. Dimensions for different scales.

The article is based on the use of audio visual aids and how it was used to complete the course objectives. The article described each section of the lesson plan. Detailed

instructions on the instructor's presentation, bibliographic references, test material, and answer keys were all examined closely. The order in which each of the abstracts were reviewed seemed to address a sequence that was similar to Gagne's sequence of learning objectives.

4. Tools and Their Uses. Rate Training Manual. (Naval Personnel Program Support Activity, 1971).

This is a student guide designed to improve the job performance of naval personnel. It's designed to help the learner identify tools and fastening equipment by their correct names. It contained valuable information pertaining to the operation of machine tools and associated measurement and inspection devices. The appendices include Autoinstructional aids. The corresponding information and other subjects are not relevant to this report.

Survey of Existing Courses and Material

The designer found many journals that related to the instructional need of this document. However, the information only defined the type of skill development necessary to bring efficiency into the learning process. Lesson plans were available in many texts that showed examples of how to read a micrometer but did not include enough information for a video training module.

The designer searched for pre-packaged courses. The designer called TPC training supplies and Round Table film and video to no avail.

Plans for Design and Development Effort

Many of the articles also indicate the importance of video presentations over other forms of media. The designer of this module decided to use video as its form of presentation for both the viewer and the trainer. The intended approach allows the viewer or the trainer the option of stopping or reviewing this lesson at any point in time. This allows for step by step instruction as the trainees advance through their lesson plan.

The use of a micrometer to create a lesson plan on the "Statistics of Instrument Error" began with the use of basic instrumentation. The micrometer was one of the few mechanical measuring devices that seemed to tie together both the electrical/mechanical technology students. The project initially began in January, 1988, and ended in May the following year. The information referred to within this document is a direct result of the research and evaluation process discussed earlier.

Project Plan

As a result of the information gathered by the designer, a video tape training module was created. The project revolved around a time line which guided the sequence of events through the final group trial analysis held in May, 1989. The PERT charts detailed the sequence of the (ISD) process. The project plans and related information can be found in Appendix E.

Budget

The designer's labor charges were calculated at $21 an hour. Fortunately, the participants for the one-on-one trials and the pilot tests participated as a courtesy. However, their hourly wage is included in the budget and estimated at $21 an hour. The video tape was estimated with a script reader at $20 an hour. The coordinator of the video tape was estimated at $75 an hour. Since many of the script cards were already completed by the designer, the cost of producing the video tape was greatly reduced. The designer determined the hourly rate based on the salaries of the coordinator and the designer. The budget displayed in Table 2 includes the cost of the original and the revised production.

Table 2

BUDGET

S.I.E.	Hours	Cost	Subtotal	
Labor				
Design Module				
analysis	20	$420		
design	20	420		
development	40	840		
field survey	10	210		
revisions	10	210		
			$2100	
Video Production				
coordinator	4	300		
manuscript	30	600		
materials		100		
equipment rentals		400		
			$1400	
Total cost of training module				$3500

Summary

A preliminary analysis indicated that the use of the measuring instrumentation was being used without the end product in mind. This training plan was analyzed to use the most accurate measuring instrumentation for measurements within one thousandths of an inch. It was intended to bring together students from all areas of engineering technology. Upon reviewing the skills that would be required, the designer decided that the taxonomy structure of this lesson plan fell into three domains: cognitive, affective, and psychomotor. The next logical step in the project plan was the design phase.

Chapter 3

Design

Introduction

The design of this module was developed to enhance the measurement capabilities of the trainees. The output of a measuring device is the information concerning the state of the process to which it is connected. The measurement obtained in this document will be compared to a standard of reference. The errors will then be reduced with the proper application.

With this in mind, the designer identified the tasks of the operation. The designer began a step-by-step approach to obtain the instructional objectives. See Chapter 2. This time the designer identified the entry behavior and sequenced the objectives according to the targeted audience. Methods for evaluating the instruction were reviewed and revised. The designer used the task force along with the information collected in the literature search.

Instructional Task Analysis

In the analysis phase the designer had determined that students in the Engineering Technology department needed a concept of measurement. The designer reviewed the information that was collected in the analysis stage, and combined it with the limitations of the lesson plan. With this information, a basis for the instructional task was formed.

In determining statistics of instrument error, trainees must first learn how to use the instrument they are going to analyze. The first phase of this program is measuring instrumentation. The concepts developed here will be used in some form throughout the SIE module, but not entirely in the segment developed here.

The tasks that will be performed on the job consist of:

1) Measuring parts that are interchangeable
2) Recording the information
3) Grouping similar information together
4) Computing the statistics of instrument error
5) Reporting the information to the instructor in a convenient manner.

In this case, the designer was familiar with the current course of instruction. The information for the entire module was in two domains, one being in the affective domain and the other being in the cognitive domain.

Instructional Objectives

The instructional goal developed in the analysis phase was determined to be in the cognitive domain of learning. The goal was to transfer intellectual abilities and skills to the targeted audience. The skills learned by the trainees would also have to be transferred over to the job environment.

Mager (1984) stated that each of the objectives should have three components: performance, conditions, and

criterion.

The objectives of the instructional unit described in this document are:

1) Given a micrometer and 20 cylinders, the trainees will read a micrometer accurately to one thousandths of an inch.
2) Given a written test, trainees will identify the various parts of a micrometer.
3) Given various measurements, trainees will be able to identify the terminology discussed in the lesson plan.

They will identify each of the above categories with a 90 percent success rate.

Entry Behaviors Defined

The entry behaviors defined for this lesson plan are:

1) Interpret whole numbers
2) Interpret decimal numbers to the nearest tenth
3) Interpret decimal numbers to the nearest hundredth
4) Interpret decimal numbers to the nearest thousandths

Group and Sequence Objectives

The designer had three objectives that were necessary for completing the instructional goal. Two of the steps were included to allow the observer the necessary information to follow the lesson plan. It then becomes apparent that the sequence of steps is important for the satisfactory

completion of this lesson plan. The main goal was stated as being in the cognitive domain of taxonomy.

Bloom (1956) organized the cognitive domain into six categories. Each category was further broken down into subdivisions for simplicity. The designer noticed the similarity associated with the cognitive and the affective classifications. The designer decided the cognitive domain was more suitable for this project. The main goal is to learn how to read a micrometer. The information seemed to overlap but the targeted goal was chosen to be in the cognitive domain of taxonomy. Next, the designer decided to sequence the objectives accordingly.

The sequencing of objects begins with the psychological process of remembering. The recognition of scales is used at the beginning of the training plan for this purpose. It allows the trainees to relate to the process involved. This requires the organization of a problem such that it will furnish cues for the information that the trainees possess. When intellectual skills are being acquired, prior learning of the situation should be related to tasks that will be newly learned (Gayne, 1988).

The terminology is presented to enforce the measurement task. It will provide the necessary association that links the scales and the associated terminology together. For example, 1/8 inch is 125 thousandths of an inch, or in decimal notation .125. The last sequence of events will

allow the trainee to process this information into a format that is needed to read a micrometer. In summary, the instructional activities were sequenced from lowest hierarchy to highest. The levels achieved and tested were: intellectual skill, cognitive skill, and attitude. It was hoped that the students would reach the highest level of motor skill development. A method for developing this skill was not developed.

Learning Activities Specification

The learning activities had to be broken down into two sessions due to the time limitations. The group meetings consisted of one hour and fifty minutes each. The class opened with a video presentation on "How to Read a Micrometer." A training package was given to the trainees as they entered the classroom. It consisted of a micrometer and 20 cylinders, 3 of which are referred to in the video presentation. The items contained in the training package would be used for observation and referenced throughout the presentation. At the conclusion of the video tape, three sample cylinders with specific diameters would be presented on the screen. The trainees would be required to measure and display the results accordingly. If a larger budget were available, this would have been the perfect opportunity to use an interactive video presentation plan. Due to limitations presented earlier, the viewer would be required to stop and review the information necessary to complete the

measuring task.

Three highlight sheets are used to present a summary of each unit. They are included in the training package to save time in reviewing the lesson plan (Appendix F).

Table 3

Learning Activity Matrix

Learning Activity	Instructional Techniques	Media
1.1	Association	Video Tape
1.2	Skill Development	Realia

The use of video presentations is a valuable tool when used properly. However, it is important to also realize that its popularity used for training purposes is limited. Video presentation is essentially a form of one-way communication. It is a carrier of information like a lecture. Therefore, it becomes important for the designer to exploit a visual presentation to allow trainee participation in the process. As Tuberville once said: "For learning to take place with any kind of efficiency, students must be motivated. To be motivated, they must become interested. They become interested, when they are actively working on projects which they can relate to their values and goals in life." (Tuberville, 1981). In reviewing the articles that pertain to video training modules, many authors seem to suggest the following:

1) Demonstration and related discussion of activities should be condensed to save time

2) Orientation of the job

3) Job organization

4) Demonstration and analysis of task execution

At the end of the presentation, a practice session will be used to demonstrate the trainees ability to operate a micrometer. The designer feels that this step is crucial because of the nature of the lesson plan. It seems that the video tape is limited in scope due to the passive rather than active training techniques. Not all of the trainees will produce the context with the same relevancy; individual differences may be ignored.

The best and most efficient way to involve the participants is to separate the trainees into pairs. The designer at this point can observe the trainees performance.

Assessment System Specification

The designer collected information about the trainees through qualitative methods. Any of the trainees that did know how to read a micrometer were tested by the administrator of the lesson plan. If the trainee demonstrated skills and in fact did know how to read a micrometer they would move on to the next phase in the training module. An embedded test was incorporated into the training module. This test was used for testing the

effectiveness of the training module without involving the participants. The participants will be measured by the trainer for measurement techniques associated with the instructional goal.

Evaluation System Specification

The evaluation methods used in this module were formative and summative. In comparing these methods, the designer would revise the contents of the program according to the findings.

Formative

In the beginning of the design phase, the designer used one-on-one trials to identify any learning deficiencies that may have existed. Once these trials were arranged to the designer's satisfaction, the next step was conducted using two small-group trials. Each step was used to improve the quality of instruction.

Summative

Kirpatrick (1987) describes the summative evaluation as four distinctive categories: reaction, learning, behavior, and results. The reaction was measured by observing the trainees. Even though the program did not specifically demonstrate how to use a micrometer, the trainees were observed on their measuring techniques. A post test was administered at the end of the lesson to verify the relevance of this training module. The learned content was reading the micrometer. The result was using an instrument that could

measure displacement up to ten thousandths of an inch.

Learning Transfer System Specification

Since many of the skills were taught in an academic environment, it is important to ensure the transfer of these skills to the job.

Before training begins it is important to identify the needs of the trainees. This can be analyzed by observing the tasks that are performed by the trainees. Meeting the needs of the trainees is an important objective and must not be overlooked.

Once the trainees are involved in the training plan, Eitington (1985) suggests centering the learning objectives around the organization's work patterns. This will aid in transferring the trainees' knowledge into the work environment. The information is intended to point out any limitations that may exist.

After training is completed, active learning generates a positive learner behavior. This can be accomplished by allowing the trainees a chance to meet with one another after the lesson plan. The SIE module specifically included steps to allow the trainees the opportunity of transferring newly formed skills to the job. Much of the evaluation process concentrates on observing the learners after the training plan was over. The sample exercises at the conclusion of the SIE lesson plan concentrated on the behavior of the trainees

after the training was completed. Grouping the trainees together allowed for an individual appraisal during and after the video lesson plan was completed.

Review and Selection of Existing Materials

No suitable materials were identified.

Summary

A design for the SIE training plan was conducted. In reviewing the instructional task, the designer decided to research video activities to determine whether active learning was necessary. The information would be collected through formative and summative evaluations. Depending upon the data collected, trainees would be allowed to develop at their own pace. The trainee's pace was subject to the results of the post test. Field trials were monitored to assure the transfer of job related skills. They were conducted according to existing courses and materials that were reviewed.

CHAPTER 4

DEVELOPMENT

Introduction

This section is devoted to developing an effective training module. Instructional activities are reviewed to reveal any discrepancies. Questionnaires and other data collection techniques are developed to evaluate the instructional objectives of this module.

Economics must also be considered in this phase. The length of time allocated to administer the lesson, along with the time necessary to properly analyze the data collected is examined. Each approach is used by the designer to develop a results-orientated program.

Learning Activity Development Scheme

After the task force completed its review of the contents needed for Physical Measurements and Analysis, a proposal was submitted to the director outlining the new updated curriculum. Once approved a new training plan was going to be created. The instruction was based on applying both measurement techniques and terminology to meet the future trend of the engineering technology students. This consisted of signal processing instrumentation. A video tape was developed to enhance the involvement of the learning process. The learning activity was arranged in a step by step process. See Chapter 3.

The development of the SIE module was created with a limited budget. The designer decided to create this module

despite the lack of funds. This was mainly contributed to the fact that in the long run it would prove to be cost effective. Therefore, the designer needed to establish a cost effective procedure that would save both time and money. In reviewing the options that were available, the designer decided that the video module would have to be developed almost entirely by himself. This was accomplished by designing a script in a specified sequence that would meet the needs of the instructional goal. Several visual aids were then developed to provide a storyboard. Fortunately, the neighbor of the designer was an artist and agreed to help draw the story boards. Some of the graphics were referenced from National Tooling and Machining Association (1981) and rearranged to meet the intended learning activity scheme. The next step was to record the SIE training module on video tape. Normally, this would have used up most of the budget, but due to the courtesy of the N.Y.I.T. video department much of the expense was deferred.

On April 1, 1988, the first recording session was planned. In the beginning, there were just two people involved. At first, the production seemed to be a complete failure because of the limited number of people. The designer then decided to produce the video module in two separate pieces and edit the two together. Fortunately, this worked and the production could then be produced according to the time line specified. Upon viewing the video recording, members of the targeted audience determined that the images

were unsatisfactory.

A meeting was held with Prof. Anthony Piazza, the executive producer for L.I. News Tonight and based on his suggestions, modifications were developed. Many of his suggestions led to the creation of new graphics with enhanced lettering on the remaining graphics. The information recorded was much clearer and easier to follow.

Learning Activity Development

The video presentation described in this document consisted of a ten-minute training module. It was presented in a classroom situation as a means of developing measurement fundamentals. The sequence of learning activities were based on Gagne's nine events of instruction (1985). The instructional events are found in Table 4.

Table 4

Instructional Events

1. Gaining Attention
2. Informing learners of the objectives
3. Stimulating recall of prior learning
4. Presenting the stimulus
5. Providing learner guidance
6. Elliciting performance
7. Providing feedback
8. Assessing performance
9. Enhancing retention and transfer

1. Gaining Attention: As the participants enter the classroom each will be handed a training activity package. This package will consist of 1 micrometer, 20 sample test cylinders and handouts. The students would be asked to review the material to avoid any disruptions during the lesson plan. The items used will excite their curiosity.
2. Informing learners of their objectives: In the beginning of the presentation three objectives are stated. Before the presentation of each section, the objective that pertains to that section is presented again
3. Stimulating recall of prior learning: After presenting the objectives, the video presents the picture of an ordinary rule. The scales are divided into tenths similar to that of a micrometer.
4. Presenting the stimulus: The stimulus is presented at the end of the lesson plan. It references the scales of a micrometer and asks the participants to measure the three cylinders contained in the training package. The trainee is to measure and compare answers.
5. Provide learner guidance: After the video presentation the trainees are broken up into groups for the second phase of the SIE module. The group is expected to work together to measure the

remaining cylinders. Any remaining problems are discovered by the trainer when the data is reviewed.

6. Eliciting Performance: The trainees are required to measure the cylinders and record the data. Each cylinder is measured, recorded, and compared with that of the handouts.
7. Providing feedback: The feedback occurs in the test items at the end of the video. Each trainee is expected to compare their measurement to that of the video tape.
8. Assessing performance: A post test was planned to be given at the end of the measurement session.
9. Enhancing retention and transfer: Since the micrometer scale is a universal scale, the information is directly applicable to any scale used in industry.

Post Test

A post test was administered at the end of the SIE training module. The test solicited information from the trainees pertaining to terminology associated with the micrometer and measurements taken from the micrometer. The post test may be found in Appendix G. The test was designed to measure the three objectives stated in the video. The information was used to measure the validity of the course content.

Peer interaction was planned at the end of the lesson

module. It was designed to give the trainees a concept of group development that is often used in industry. The data collected is also another way of converting a passive video training package into activities that enhance retention. The original project was completed as planned.

Learning Activity Review

College catalogues were originally reviewed for curriculum outlines. Once the appropriate course content was located, it was compared to the training developed by the designer.

The task force also reviewed the instructional materials along with the director of the department. Once the subject matter and content were reviewed, the video was prepared for its first trial.

Materials for Formative Evaluation Produced

The materials for evaluation were produced. These included the video as well as an observer checklist, post test, and questionnaire.

Summary

The instructional material developed was based on Gagne's nine instructional events. A ten minute video training plan was produced. The video module was reviewed and analyzed for discrepancies in the delivery of the intended lesson. Evaluation plans were developed and examined.

CHAPTER 5

IMPLEMENTATION

Introduction

An integral part of the SIE design module consisted of implementation of the program. In the beginning, participants should be alerted that the program that they are involved in is an active program designed to maximize the learning experience. This is designed to influence the results to be obtained.

The one-on-one trial was conducted using two members of the targeted population. After removing the obvious errors that were encountered by the trainees during the one-on-one interview, a video tape was produced. A small group trial was conducted twice and improved for a field trial. Members of the original task force observed the classes and made suggestions. Information was also solicited from members of the target population and considered for improvements of the module. Based on the information collected, changes in the program were necessary.

Materials for Implementation Reproduced

A video tape that consisted of the SIE module was reproduced three times. Also, three test cylinders were produced with a copy of the handouts as part of a training package. The final versions of the instructional materials may be found with the training package in Appendix F.

Instructional Delivery

The video training module was produced two times during the spring of 1988. The time allocated for the lesson plan was scheduled for one hour and fifty minutes in one of the N.Y.I.T. laboratories.

The implementation was held one year later. This was because of scheduling problems and was conducted on April 24, 1989. The training module was revamped with all the changes included from the previous trials. The video lesson plan was implemented with four seniors, ten sophomores, and one freshmen from the engineering technology curriculum.

The lesson was changed many times to finally arrive at the desired goal which was achieving a 90 percent success rate. The actual level attained was 87 percent, and did not quite reach the desired level. The video module became skill oriented which involved the additional use of practice items.

Data Collection

At the end of each trial session the students were required to complete a post test and a questionnaire. Copies may be found in Appendix G and in Appendix H. The questionnaire was designed to measure the student's reaction to the lesson plan. The information obtained measured their reactions to the information that was contained within the lesson, and the method for determining the contents of the lesson plan.

A post test along with an instructor worksheet collected data on job skill development. It identified three specific areas that pertained to the lesson plan. The information collected was then used for a summative evaluation process. The origional version of the instructor guide may be found in Appendix I.

Summary

The video module was completed slightly behind schedule. Many of the materials were reproduced for implementation purposes. The learning activity was reviewed throughout the formative evaluation process, and was improved for each subsequent trial. The information contained in each video module was the same except for the addition of a micrometer in the beginning of the second group evaluation. The number of practice items also increased in the field trial. Each stage of the formative evaluation helped identify and remove any problems that existed. Different groups were selected to ensure that the data collected was representative of the target population for which the materials are intended.

CHAPTER 6

Evaluation

Introduction

There are many ways in which training programs are assembled into structured lecture plans. The classic model requires the trainer to consider evaluation techniques in which "hard" data is collected. This requires information upon which the delivery plan was structured. Therefore, evaluation becomes an integral part of the lesson plan that must be integrated throughout the design phase. Once the initial field trial is conducted, the evaluation is further reviewed to assess the program effectiveness. Minor alterations are usually considered if feedback mechanisms are properly conducted. It also aids in the formation of essential statistical approaches for solving a wide variety of problems.

The evaluation in this program was carried out in two steps commonly known as formative and summative evaluations. Each step is specifically designed to compare on-the-job performance before and after training for evaluation purposes. Dick and Carey (1985) state that the measurable indicators of task performance identified in the task analysis will be used as a performance test while the after-training performance will be equal to or surpass the acceptable limits of performance determined in the task analysis. The final evaluation is then expected to increase

the instructional outcome of the learning activities.

Formative Evaluation

Dick and Carey (1985) state that there are three basic principles of formative evaluation: one-on-one, small-group, and field trials. Each requires the use of learners that are representative of the targeted population.

The first small group evaluation was planned for April 12, 1988. It was finally conducted on April 22, 1988. The delay was caused by the corrections that had to be made during the one-on-one evaluations. There were 18 students present. Many of the students were from the electrical engineering technology curriculum. It was the first lesson used in the SIE training module.

After reviewing the lesson, the trainees were allowed ten minutes to structure their new measuring skills with that of the micrometer. In observing the trainees, the designer decided to modify the video presentation plan. This incorporated the use of a micrometer that would be presented in the beginning of the video presentation.

The second small group evaluation was held on May 18, 1988. The audience consisted of ten members. The group again represented a large portion of electrical engineering technology students. The only difference was, this time the group consisted of evening students.

Five of the evening students were allowed to move on to the next step of the training plan because they were already

familiar with the micrometer. The fact that these students already knew how to read a micrometer from their job confirmed the data collected during the needs analysis. At first, there was a little confusion in separating the skilled groups from the others. However, the training proceeded as planned.

In observing students performing the measuring tasks on the three sample cylinders, this designer noticed a lot of anxiety. It seems that the students wanted to perform their measuring tasks but were still having trouble assembling the measurements on the three practice items. The problem was corrected by giving the students additional examples and more time to complete the measuring task.

One-on-One Trials

A one-on-one trial was originally performed to evaluate the learning process. The purpose of the one-on-one stage was to remove the most obvious errors in the instruction. The reactions to the initial lesson plan were observed through direct interaction between the designer and the trainee. One-on-one evaluations occur when the designer works with individual members of the targeted population. In the SIE module the one-on-one evaluations provided valuable information concerning the order in which events were to take place. Two students were asked to review the lesson plan outline, while the designer guided the trainee through any areas that were unclear. Each student was chosen from the

target audience. The students generally encountered problems in locating the reference line from which the scale is read. The next area of concern was in the arrangement of numbers that were read from the scale. It seemed that since the trainees were familiar with the scale they could arrange the numbers in their head to arrive at the correct answer. This proved to be an unsound method, so examples of how to add fractions were included in the video lesson plan.

Small-Group Trials

Once the designer corrected the problem areas that existed in the one-on-one interview, the next step was to determine if the changes had any effect on the audience.

The first small group trial was conducted on May 22, 1988. The session was scheduled to take place in a course known as Physical Measurements and Analysis. The video tape and the instructional materials were ready. The training package consisted of one video lesson plan, a copy of the handouts, and twenty test samples. Three of the 20 cylinders would be used in the video as sample measurements. The instruction was scheduled for the first day of the training session. The video itself used about ten minutes of the allotted time period. The remainder of the time was spent on the test samples and the second part of the SIE module. This consisted of collecting data with the micrometer that would be used for statistical analysis.

There were 18 students scheduled for the original lab

course. There were six seniors, ten sophomores, and two freshmen present from the engineering technology area. Two members of the original task force were also present. Each observed the lesson content along with the trainees' responses. They felt that this lesson plan was a good introduction which could be used in other classes in the mechanical technology curriculum.

The trainees seemed to have trouble with the speed in which they executed the task. Upon reviewing the audience response, it seemed that in the one-on-one trials, the handling of the micrometer was over looked. The lesson plan revealed this, when the trainees were observed in performing their tasks. This resulted in changing certain graphics and allowing a live demonstration, entailing the use of the micrometer. This resulted in the changing of the script.

The second small group trial took place on May 18, 1988. It consisted of one junior, three sophomores, and one freshman. The trial was again held in a course known as Physical Measurements and Analysis but this time the trial was held with evening students. Each of the ten students were members of the engineering technology area. The only difference this time was that many of the trainees were presently working in the industrial environment. Five of the members of this audience already knew how to read a micrometer they completed the post test in back of the training package and moved on to the next step of the SIE

module. The embedded test that were processed during student trials. The remaining members followed the training plan schedule. It turned out the trainees viewed the lesson plan at a faster rate than previously experienced. It also determined that the module could be taught without any interaction from the instructor. Many of the trainees contributed to the success of the module through both one-on-one and small-group evaluations.

Pilot Test

A pilot test was not conducted due to scheduling problems. If it were conducted the trainees would have been required to complete the learning materials on their own. Upon reviewing the video lesson plan, this designer would have asked each student the same questions that were posed to the students that participated in the one-on-one and small group evaluation.

Summative Evaluation

There are four levels of summative evaluation described by Kirkpatrick (1987). They are: reactive, learning, behavior, and results. The designer applied this format for measuring the learning tasks that have taken place. The post questionnaire developed consisted of questions for evaluating the trainees' responses to:

1. opinions of the program
2. learning objectives

Reaction

The post questionnaire was designed to allow trainees to anonymously answer and submit their reaction to the program. The questionnaire also allowed for comments at the bottom for which trainees could provide information not covered. The questionnaire distributed at the first trial had eighteen responses. Each indicated that they liked the video but felt that more visuals were needed on how to operate the micrometer. The post questionnaire may be found in Appendix G.

Question #1. Fourteen students rated the class as excellent, two students rated the class as good and two other as fair.

Question #2. Twelve of the students felt that the information was needed to complete the job while the remaining six students felt that it stated the proper objectives.

Question #3. Ten of the students felt that the practice items were sufficient but felt that more were needed for skill development. Eight felt the practice items were adequate.

Question #4. Do you feel that this lesson should be changed in any way. Thirteen respondents felt the lesson was different and would not change the format, while five would.

Written comments:

1. More practice items.

2. Include more information.

3. Include more action shots.

The second trial test was conducted with five trainees. The questionnaire produced the following results.

Question #1. Four of the students rated the lesson as excellent, while one rated it as fair.

Question #2. Five of the students felt that there was enough information necessary to complete the lesson.

Question #3. Five of the students felt that more practice items were needed to complete the task.

Question #4. Three of the trainees felt that the lesson needed more information on the micrometer while two felt it was adequate.

Written comments:

1. More examples on reading the micrometer.

The third trial, implentation consisted of fifteen members. This time the respondents seemed to readily adopt to the video lesson. The trainees reviewed the objectives and the results are as follows:

Question #1. Thirteen of the trainees rated the program as excellent, one as good and one as fair.

Question #2. Ten of the trainees felt that there was enough information to complete the task while four others felt it met the objectives presented in the video module. However, one student felt it needed more.

Question #3. Fourteen students felt that the practice

items were appropriate, while one student felt they were not.

Question #4. Thirteen students felt that the lesson did not have to be changed. Two student felt that more practice time was needed.

Written comments:

1. The examples at the end of the video need to be displayed for a longer period of time.
2. The information was good.

The majority of the information extracted from the trainees was evaluated from the five questions referenced in Appendix H. Many of the comments were favorable. The questionnaire did evaluate the respondent's need for more practice examples and an additional shot of someone using the micrometer. The information was included in the video and is seen as having had some impact upon the last presentation.

Learning

A post test was administered to evaluate the learning that took place. Each member was required to participate. The information solicited was to name several parts of the micrometer, the terminology associated with the micrometer, and measurements obtained using a micrometer. Data was collected and used to reflect the amount of time the trainees needed to complete the task. The test was composed of eight fill-ins and two measurement readings. The post test and evaluation forms are located in Appendix H. The results are found in Table 5.

Post Test Results

Trial 1

Score	100	90	80	70	
# of participants	14	1	3	0	= 18
% of participants	77%	05%	16%	0%	

(Avg Time) To complete 20 measurements was 15 minutes

Trial 2

Score	100	90	80	70	
# of participants	3	2	0	0	= 5
% of participants	60%	40%	0%	0%	

(Avg Time) To complete 20 measurements was 11 minutes

Trial 3

Score	100	90	80	70	
# of participants	12	1	2	0	= 15
% of participants	80%	06%	13%	0%	

(Avg Time) To complete 20 measurements was 12 minutes

The first small group evaluation consisted of eighteen students. The results indicated that additional modifications were necessary. There were eighteen students present and fifteen of them completed the post test with a grade of ninety percent or better.

The second small group evaluation consisted of five students. The results indicated that the modifications made to the lesson plan were a success. There were five students present and each completed the post test with a 90 or better.

The implementation was conducted using the revised and final version lesson plan. Fifteen students received the post test, and thirteen of them completed the test with a 90 or better. The modifications made to the second lesson plan appeared to be a success. The average time needed to measure the 20 cylinders was 12 minutes compared to 15 minutes that were needed by the trainees during the first group trial. However, the second small group evaluation had additional examples added on at the end of the video lesson. The time needed to complete the measurement of 20 cylinders had no considerable impact. The results did increase from the first small group evaluation to the final trial. However, the results of the second small group trial compared to the final trial seemed to decrease. This could have contributed to the number of trainees that were present at each session.

Behavior

Kirkpatrick (1987) states that the appraisal of behavior should be done by the trainee's subordinates, trainee's supervisors, or by the trainee's peers.

Unfortunately, the designer was unable to measure the behavior and results of the trainees due to the time that was allocated for this project. In addition, it is not customary for supervisors to work with their instructors in a classroom setting in higher education. Therefore, the observation of behavioral change would have been difficult to obtain.

Results

The success of any training program is measured by results. If the results are effective, there will be a noticeable behavior change on the job. The results were acted favorably upon by trainees and employees of New York Institute of Technology. The trainees were now able to measure with a medium resolution measuring device. However, the actual results were not recorded. The results were only observed by performance in the remainder of the lesson plan.

Learning Transfer

When designing a program such as this, it is important to get management involved in the process. By doing so it adds to the success of the program. In many cases management support, job linkage and follow up procedures are use by the designer to increase the results.

In this training program, pre-training was not necessary because the targeted population already contained the necessary information needed to complete the program.

Broad (1980) states that the transfer of learning behavior can improve performance in the current job. It seems that the working environment receives the least amount of attention and holds the greatest resources for ensuring the transfer of learning. Therefore, by knowing more about the working environment, this module will better assist the design of instruction.

Since this video program will be used in an industerial setting. managements support during this period can help influence the success of the program. This can be done by rewarding the trainees, offering compensation time needed during the initial training period or simply by offering a certificate at the end of the program.

Linking the newly learned skills toward job related skills is a good way to encourage and help transfer learning experiences. Follow up procedures are also used to increase participation if it is implemented properly. If supervisors don't support or instigate the use of new learned skills upon the trainees returning to work, the skills will gradually fade away.

Employee participation can be recognized by a return on investment. However, a return can be produced by the number

of manufactured parts or a change in attitude or both. The results are often long term and do not lend themselves toward immediate success rates.

In quality control programs the accuracy of measurements taken with a micrometer can only be recognized after the merchandise has been assembled. This could be months down the road.

Many industries are reluctant to provide training because they can't visualize a return on their investment. The cost of many training programs seems to be a major factor that prevents their support. This must, therefore, be demonstrated by documenting the programs success rate.

Summary

Two field trials were conducted. After completing the necessary revisions, the SIE module was implemented. At the end of each trial the trainees were given a questionnaire and a test. The questionnaire measured reactions to the training program while the test measured learning skills. The reaction to the training plan was favorable, and produced a successful level of achievement. This consisted of eighty-87 percent of the trainees finished 87 percent of the information 87 percent of the time. Much of the success was attributed to the skills developed through active learning techniques that were incorporated throughout the lesson plan.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

Introduction

The information contained in this section is a summary of this document. It reviews the methods the designer used in creating this document and possible recommendations that pertain to this training plan. Suggestions are given for those who wish to use this project in the future.

Methods and Procedures Used

The method used in this Thesis/Project was based upon the Instructional System Design process that consisted of five components: analysis, design, development, implementation, and evaluation.

Analysis

The designer analyzed the training plan based upon the need for updating recent technological advancements in instrumentation. The needs of the target audience were arrived at from surveys of existing courses, faculty members, and through the demands of industry.

The analysis identified the need for determining a working knowledge of measurement units. This required the accumulation of data with standard international measurements within ten thousandths of an inch. The need for more accurate dimensioning continues today.

Design

The designer established the objectives of the lesson plan and arranged them in a specific sequence to facilitate learning. The lesson plan was based on skill development. The lesson plan was determined to require one hour and fifty minutes.

Non-reactive measurement techniques were used to collect data about the trainees. An embedded test and post test was included in the training plan to measure learning.

Development

The lesson plan was developed using Gagne's nine instructional events. Sample test items and highlight sheets were included in the training packet. Post-exercises were also included to change a passive lesson plan into a learning activity.

Implementation

Three trials were conducted with the SIE video module. The target population consisted of freshmen, sophomores, juniors, and seniors in the engineering and technology area. The third trial was conducted with revisions from the first and second trials. Each time a learning questionnaire and a test were used to revise the material.

collected at each trial and revised for the next trial. At first, a one-on-one trial was conducted to establish any learning deficiencies that existed. Two small group trials was then arranged which resulted in the addition of graphics and the use of more sample exercises.

The summative evaluation was then used to evaluate the validity of the material through Kirpatrick's four criteria: reaction, learning, behavior, and results. Reaction was measured through a post learning questionnaire. The effect of the material was measured through a post test. Eighteen students participated in the first test. Fifteen of the participants passed the criteria. The trial consisted of five participants, five of whom also exceeded the criteria. The third trial for implementation seemed to be better than the first but not as effective as the second trial. However, the second and third trial were considerably better then the first. Overall, the training module is considered a success and fell within 3 percent of the stated criteria.

Conclusions

The trainees who were present in the second field trial consisted of trainees who are presently working in an industrial setting. Many of the trainees are already familiar with a micrometer. This in itself demonstrated how often a micrometer is used in a job setting. Out of ten

evening students, five used this instrument in their every day activities. Each of the individuals who were familiar with the micrometer, completed the post test in the back of the training package and moved on to the next step. The information that was presented in the training plan was not too difficult. However, without the use of many of the training techniques that surrounded this project, the training plan would not have been as effective.

The one-on-one and small group evaluations provided were very useful and helped validate the results. It indicated that changes were in order. The information gathered by the designer through observing the trainees proved to be valuable to both the trainee and the designer.

Recommendations

If the designer continued through with the SIE module, an entire lesson plan would have been completed. In reviewing the video tape, this lesson plan could be used in both small groups or individually. The only recommendation I would like to see added is the inclusion of acronyms for identifying the various parts of the micrometer.

The classic complaint that occurred from using a micrometer as opposed to other measuring devices is, "Why don't we use other instruments instead of a micrometer?" This common complaint can be answered a few different ways.

First, the trainer must point out that the micrometer is

a tool for learning, and its purpose is for developing principles, concepts, and work forces. Presenting the information in the proper context is the main objective of the three-part lesson plan. Naturally, this video tape teaches the use of a micrometer and therefore, can be used in other areas that require the accuracy of a micrometer.

The designer would have developed additional material to be used in the three-day training. The remaining two sections are important in making the SIE training independent from any instructor based training. The information in the first phase of formative and summative evaluations concluded that this module could be successfully implemented without any outside intervention.

Concluding Statement

In the long run, the cost of developing the video cassette will hopefully outweigh the cost of developing any other type of training package. In almost all cases the trainees accepted this training for what it is, a tool for learning. The persistent inability to transfer classroom training into on the job training may indicate the trainees resistance to what is being taught. The actions that were observed by the designer concluded that some of the trainees persistently decided to pick the training plan apart instead of just saying that they disagree with the concept. However,

this consisted of approximately 5 percent of the total population.

The potential to produce new and different ideas for solving problems often remains unused. The need for trainers to utilize different tools for developing and stimulating trainees insight, is an on-going concern. However, the rewards generated outweigh the limitations which trainers faced in almost every situation. The video training plan presented here is an attempt to improve the way instructional materials have been presented in the past. As a result, this project has been included as part of the SIE module at New York Institute of Technology, and in other areas that must use accurate and reliable measurements.

APPENDIX A

SIE Audience Analysis Form

Questionnaire

Name: Date:

SS#: Telephone#:

Address:

Male:_____ Female:_____

Last School Attended:_____

Grade Level Completed:_____

Employment Background:_____

Present Employer and Job Title:_____

Previous Employer and Job Title:_____

1) What was the title/name of the last math course you took?

---

2) Have you had any previous experience with fractions or decimals?

If so, can you add and subtract them? Yes___ No___

3) Are you familiar with the concept of thousandths of an inch? Yes___ No___ How many thousandths are represented here? 0.06; _____

4) Do you think a Micrometer will be of any use to you in the future? Yes___ No___

Audience Analysis
(Trial 1)

1) Calculate the number of people that are familiar with a micrometer. Out of 18 surveyed, 1 are familiar with a micrometer.
2) Calculate the number of people familiar with decimal notation. Out of 18 surveyed, 18 are familiar with a decimal notation.
3) When can these people meet? At scheduled lab hours.
4) Is this instrument going to be of any use in the future? Out of 18 surveyed, 15 will possibly use a micrometer in the future.
5) Are there any comments you would like to make: No comments were made.

Audience Analysis
(Trial 2)

1) Calculate the number of people that are familiar with a micrometer. Out of 10 surveyed, 5 are familiar with a micrometer.
2) Calculate the number of people familiar with decimal notation. Out of 10 surveyed, 10 are familiar with a decimal notation.
3) When can these people meet? At scheduled lab hours.
4) Is this instrument going to be of any use in the future? Out of 10 surveyed, 10 will possibly use a micrometer in the future.
5) Are there any comments you would like to make: No comments were available.

Audience Analysis
(Trial 3)

1) Calculate the number of people that are familiar with a micrometer. Out of 15 surveyed, 0 are familiar with a micrometer.
2) Calculate the number of people familiar with decimal notation. Out of 15 surveyed, 15 are familiar with a decimal notation.
3) When can these people meet? At scheduled lab hours.
4) Is this instrument going to be of any use in the future? Out of 15 surveyed, 10 will possibly use a micrometer in the future.
5) Are there any comments you would like to make: No comments were available.

APPENDIX B

Needs Survey

Student 1. Mathematics courses last completed:

3011 -College Algebra and Trigonometry

Knowledge of statistics: None

College level completed: 2nd semester freshman

Did you ever use a micrometer or other displacement measuring equipment accurate to one thousandths of an inch : No

---

Student 2. Mathematics courses completed:

3011 - College Algebra and Trigonometry

Knowledge of statistics: None

College level completed : 2nd semester freshman

Did you ever use a micrometer or other displacement measuring equipment accurate to one thousandths of an inch: No

---

Student 3. Mathematics courses completed :

3320 - Technical Math II

Knowledge of statistics: None

College level completed: 1st semester freshman

Did you ever use a micrometer or any other displacement measuring equipment accurate to one thousandths of an inch: No

---

Student 4. Mathematics courses completed :

3330 Technical Mathematics III

Knowledge of statistics : Used in quality control.

College level completed: 1st semester sophomore

Did you ever use a micrometer or any other type of measuring equipment accurate to one thousandths of an inch : yes

---

Student 5. Mathematics courses completed:

Technical Math III

Knowledge of statistics: none

College level completed: 2nd semester freshman

Did you ever use a micrometer or any other type of measuring equipment accurate to one thousandths of an inch: Yes, at work

APPENDIX C

The Right Tools At The Right Time

The SIE module was broken down into modules in-order to provide the right tools for the learner at the right time.

Day 1. Tools needed for first day

The trainees are presented a video lesson package that consists of a micrometer, 3 samples that will be presented at the end of the lesson plan, and 20 test samples.

The students will measure the three test samples and compare their measurements to the samples displayed in the video tape.

The students will then break up into groups to measure 20 test samples which will be collected at the end of the first day.

Day 2. Tools needed for second day

The students will remain in groups and measure 120 cylinders.

Day 3. Tools needed for third day

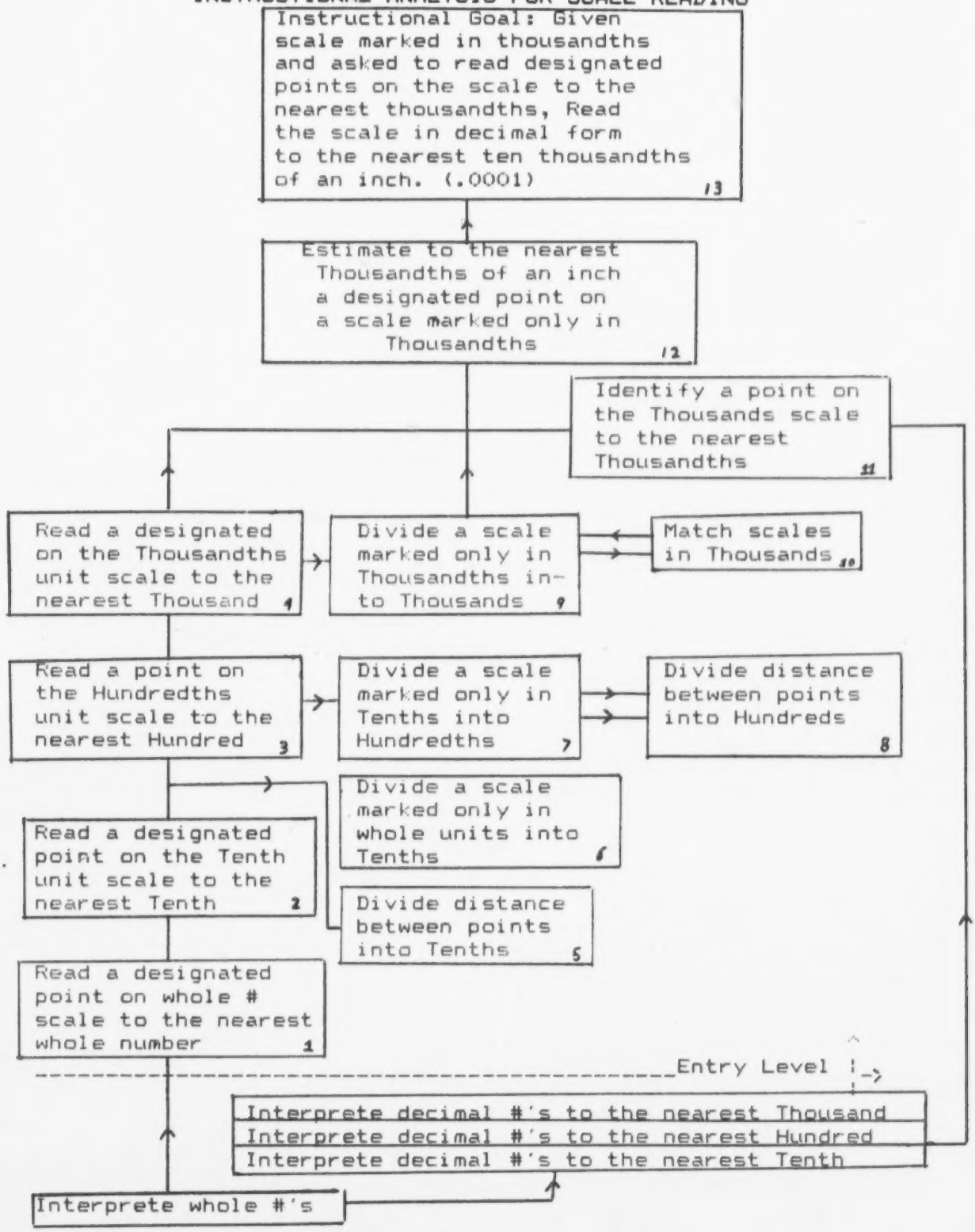
Students will be presented with a lesson plan on the Statistics of Instrument Error. Various calculations will be made with the measurements that were taken. Project will be submitted by the trainees in specified formats.

APPENDIX D

Instructional Analysis Form

for Scale Reading

INSTRUCTIONAL ANALYSIS FOR SCALE READING


Instructional Goal: Given scale marked in thousandths and asked to read designated points on the scale to the nearest thousandths, Read the scale in decimal form to the nearest ten thousandths of an inch. (.0001) 13
Estimate to the nearest Thousandths of an inch a designated point on a scale marked only in Thousandths 12
Identify a point on the Thousands scale to the nearest Thousandths 11
Read a designated on the Thousandths unit scale to the nearest Thousand 4
Divide a scale marked only in Thousandths into Thousands 9
Match scales in Thousands 10
Read a point on the Hundredths unit scale to the nearest Hundred 3
Divide a scale marked only in Tenths into Hundredths 7
Divide distance between points into Hundreds 8
Divide a scale marked only in whole units into Tenths 6
Read a designated point on the Tenth unit scale to the nearest Tenth 2
Divide distance between points into Tenths 5
Read a designated point on whole # scale to the nearest whole number 1
Entry Level
Interprete decimal #'s to the nearest Thousand
Interprete decimal #'s to the nearest Hundred
Interprete decimal #'s to the nearest Tenth
Interprete whole #'s

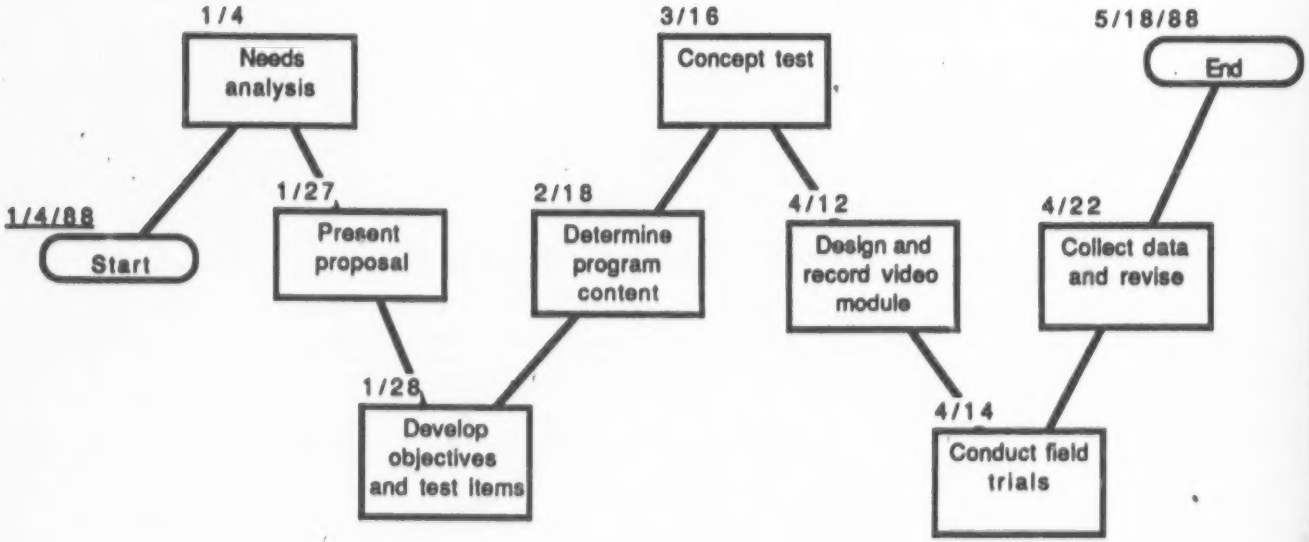
APPENDIX E

Project Planning

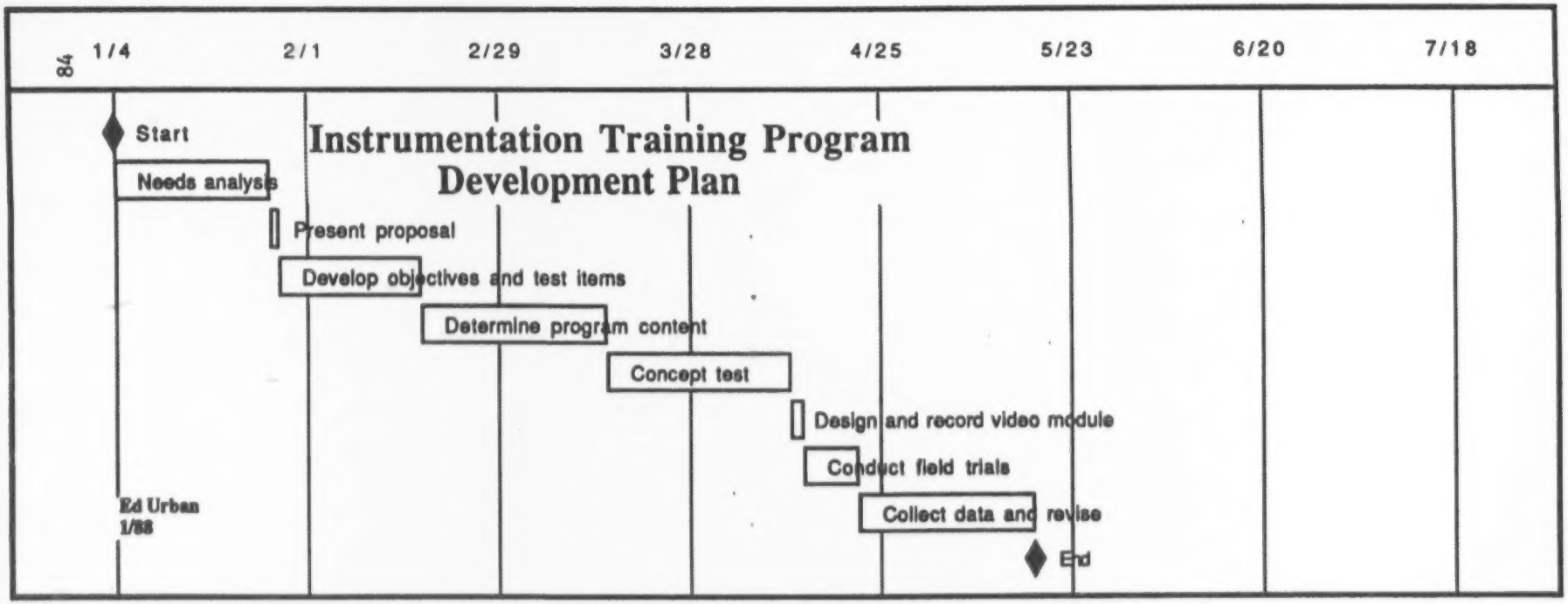
Sequence of events

		Start	Finish
1)	Start	1/1/88	1/1/88
2)	Needs analysis	1/1/88	2/18/88
3)	Present proposal	2/18/88	2/18/88
4)	Developed objectives and test items	2/18/88	3/1/88
5)	Determine program content	3/1/88	3/20/88
6)	Concept Test	3/1/88	3/20/88
7)	Design and recorded video module	3/30/88	4/1/88
8)	Trial 1	4/18/88	4/18/88
9)	Collect data and revise	4/18/88	5/17/88
10)	Trial 2	5/18/88	5/22/88
11)	Collect data and revise	5/18/88	5/22/88
13)	Trial 3	4/24/89	4/24/89
14)	End		

Instrumentation Training Program Development Plan

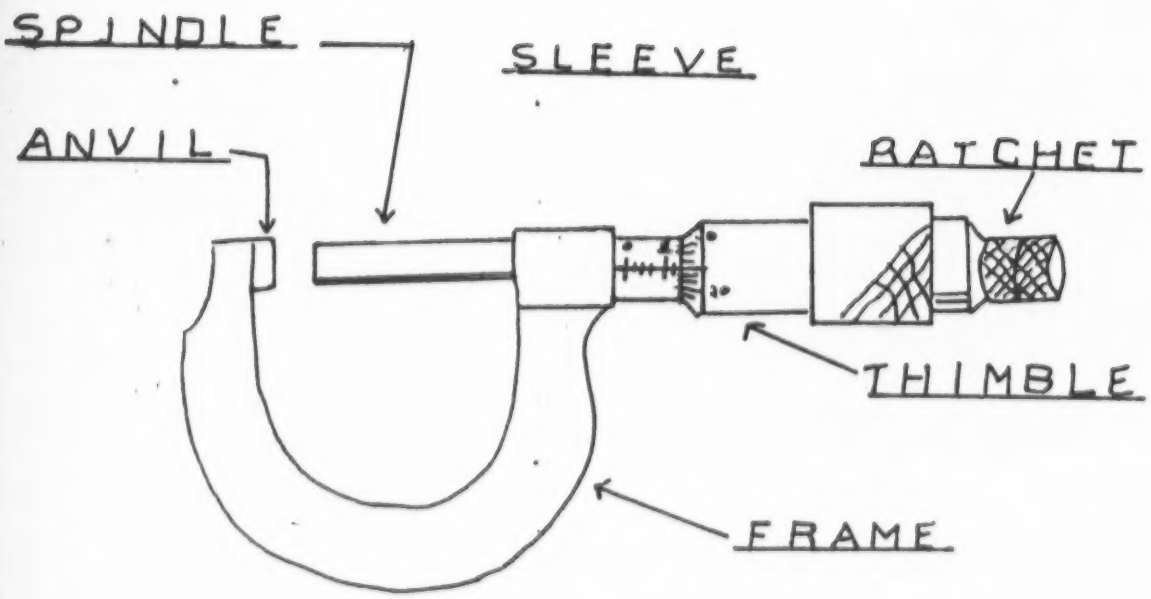


Ed Urban
1/88

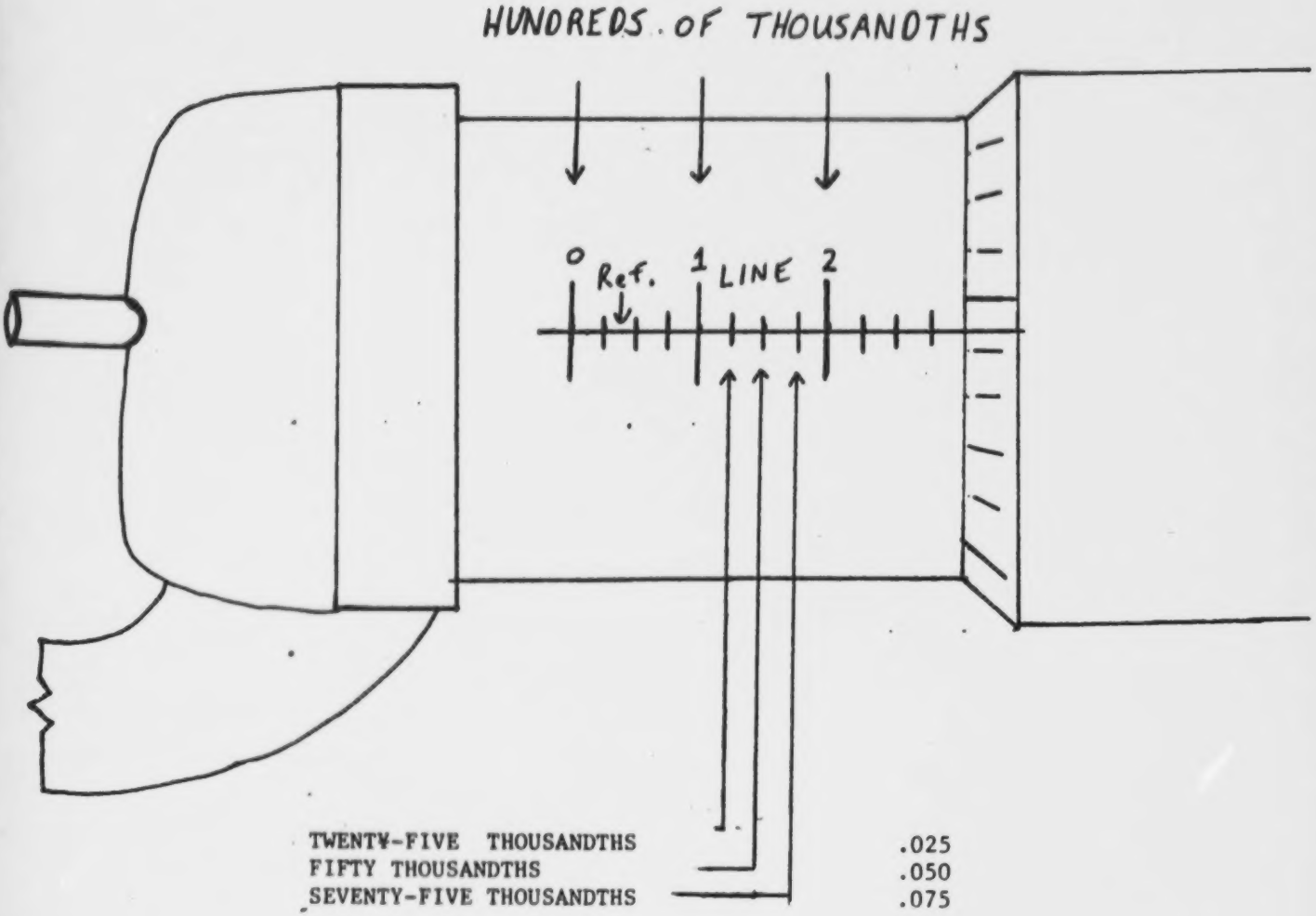

84
1/4
2/1
2/29
3/28
4/25
5/23
6/20
7/18
Start
Instrumentation Training Program
Development Plan
Needs analysis
Present proposal
Develop objectives and test items
Determine program content
Concept test
Design and record video module
Conduct field trials
Collect data and revise
End
Ed Urban
1/88

APPENDIX F

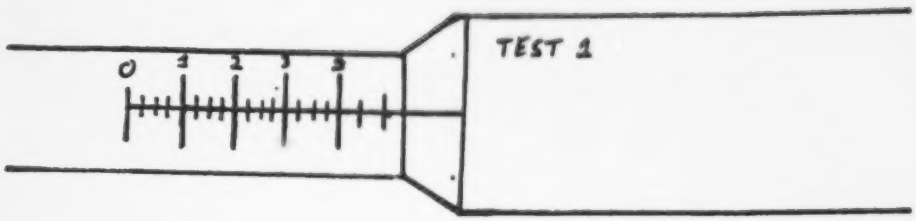
Training Package

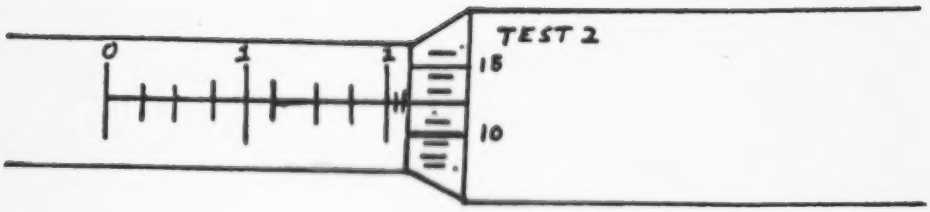

SPINDLE
SLEEVE
ANVIL
RATCHET
THIMBLE
FRAME

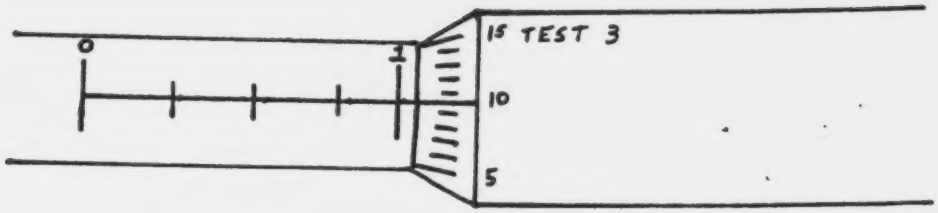
TERMINOLOGY



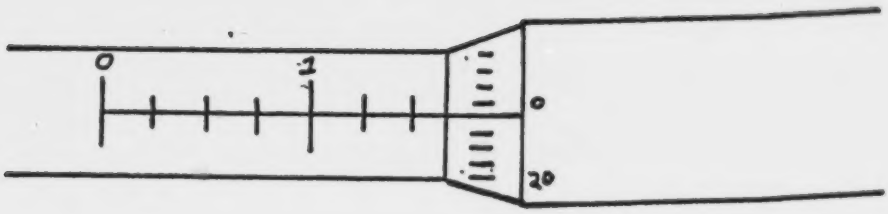
TEST






0
1
15 TEST 3
10
5

EXAMPLE PROBLEM



0.000	INCH
0.100	HUNDRED THOUSANDTHS
0.050	TWO QUARTERS OR FIFTY THOUSANDTHS
0.024	TWENTY-FOUR THOUSANDTHS
0.174	ONE HUNDRED SEVENTY-FOUR THOUSANDTHS

APPENDIX G

Post Test

Post Test

Name_____

Date_____

Number One

Upon using a medium resolution measuring device such as a micrometer, accurate measurments can result.

Please list as many of the parts that make up the micrometer as possible.

1._____

2._____

3._____

4._____

5._____

Number Two

Please list the terminology often associated with the measurements below.

1. (0.025)_____

2. (0.001)_____

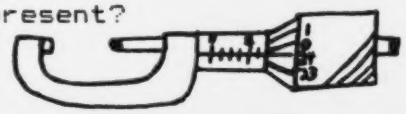
3. (0.010)_____

4. (0.100)_____

Number three

What number does this micrometer represent?

_____



The test has ten questions worth ten points each, for a total of one hundred points.

APPENDIX H

Post Learning Questionnaire

Post Learning Questionnaire

1) How do you rate the content of this lesson plan.

   Excellent____ Good____ Fair____

2) Was the material directly related to:

   a. On job performance

   b. Information needed to complete the task

   c. The stated objectives

3) Were the practice items appropriate:

   Yes____ No____

4) Do you think the lesson plan should be changed in any way? Yes____ No____

5) Please fill in recommendations for improving the lesson plan._____

   _____

   _____

Post Learning Questionnaire
Trial #1

1) How do you rate the content of this lesson plan.

Excellent 14 Good 2 Fair

2) Was the material directly related to:

# of students

0 a. On job performance

12 b. Information needed to complete the task

6 c. The stated objectives

3) Were the practice items appropriate:

Yes 10 No 8

4) Do you think the lesson plan should be changed in any way? Yes 13 No 3

5) Please fill in recommendations for improving the lesson plan._____

_____

_____

Post Learning Questionnaire
Trial #2

1) How do you rate the content of this lesson plan.

Excellent 4 Good 0 Fair 1

2) Was the material directly related to:

# of students

0 a. On job performance

5 b. Information needed to complete the task

0 c. The stated objectives

3) Were the practice items appropriate:

Yes 0 No 5

4) Do you think the lesson plan should be changed in any way? Yes 3 No 2

5) Please fill in recommendations for improving the lesson plan._____

_____

_____

Post Learning Questionnaire
Trial #3

1) How do you rate the content of this lesson plan.

Excellent 13 Good 1 Fair 1

2) Was the material directly related to:

# of students	
10	a. On job performance
5	b. Information needed to complete the task
0	c. The stated objectives

3) Were the practice items appropriate:

Yes 14 No 1

4) Do you think the lesson plan should be changed in any way? Yes 2 No 13

5) Please fill in recommendations for improving the lesson plan._____

_____

_____

APPENDIX I

Video Script

Video Script

As modern production methods demand increasing part accuracy, gauges and measuring tools become more and more important in assuring product conformance to specification. Higher accuracy requires demand not only measuring instruments of greater complexity, but also more skillful use, for a reasonable assurance of accuracy.

The most common measuring instrument in the shop is the steel rule. This is made from tempered steel, and is accurately graduated into inches and fractional inches. For example, a common inch rule usually has one side graduated into eights and sixteenths.

The steel rule is satisfactory for determining approximate dimensions in rough machine work, layout work, and checking specifications. However, machinists can obtain a much higher degree of accuracy by measuring with a micrometer.

The objectives of the lesson plan are:

1. To identify the parts of the micrometer.
2. To learn the terminology associated with a micrometer.
3. To learn to read a micrometer.

The scale associated with a micrometer is read in the same fashion as that of an ordinary rule.

The major parts of a micrometer are shown here.

In order to discuss how to measure with a micrometer, we should first learn the names of these parts.

1. The anvil is one of the two faces between which the work is measured.
2. The spindle is the other of the two measuring faces, which moves by adjusting the thimble.
3. The frame holds the anvil in place, and is usually rested in the palm of your hand when measuring.

---

4. The sleeve scale scale of a micrometer is divided into ten main parts, each part equaling one

hundred thousanths of an inch, or .100. Each main division on the scale is then sub-divided into four equal parts of twenty-five thousandths. That's .025 of an inch, each.

---

5. The thimble scale has a beveled edge that is divided into twenty-five equal parts, each part is equaling one-thousandths of an inch. These thousanths are marked conveniently 0, 5, 10, 15, and 20 thousandths. One complete revolution of the thimble is twenty-five thousanths of an inch.

Some micrometers are equipped with a ratchet stop or with a friction thimble mechanism to control the pressure exerted on the work you are trying to measure. Since different amounts of pressure will produce different measurements, the ratchet stops at a predetermined force. This allows different people to use the same micrometer with uniform results.

In the friction thimble micrometers, the friction thimble is built into the upper section of the thimble. The lower section remains constant with each turn. This allows one-handed operation of the micrometer. The ratchet micrometer requires two handed operation.

The next objective is to learn how to read a micrometer.

The sleeve of the micrometer shows a reference line graduated into hundreds of thousandths of an inch, shown by the number on the barrel. They represent, One hundred thousandths of an inch, .100 Two hundred thousandths of an inch, .200 Three hundred thousandths of an inch, .300 all the way up to ten hundred thousandths of an inch, which equals one inch, 1.0.

The reference line is further sub-divided into four twenty-five thousandths of an inch incruments, between each hundred thousands.

The first of these quarter-marks after a number equals twenty-five thousandths

of an inch, or .025. The second quarter indicates fifty-thousandths of an inch, or .050. The third is equil to seventy-five thousandths of an inch, or .075. The next marker is found under the next hundred-thousandths numeral.

The way in which you expose these calibrations on the sleeve barrel is by rotating the thimble.

One complete revolution of the thimble represents twenty-five thousandths of an inch, .001. The thimble is conveniently marked at 5, 10, 15, and 20 thousandths, or .005, .010, .015, .020.

To review, with the material against the anvil, turn the thimble until the spindle rests firmly against the material. Then record the highest numeral that is visible on the sleeve reference line, in hundreds of thousandths.

Then record the value of the quarters visiable after the last hundred thousandths numeral. Then record the

number of thousandths indicated on the thimble calibration. By adding these three quantities, you arrive at the total measurement.

Here are your three examples that you may use to test your micrometer skills.

Look at each one; write down the hundred thousandths, quarters, and thousandths in a column, add them, and check your answers.

APPENDIX J

Instructional Video Locator Sheet

The instructional video tape that was produced in this thesis/project is available at the office of the graduate program in Master of Science, in Training and Learning Technology, New York Institute of Technology old Westbury, N.Y. 11568. The format of the tape is 3/4 inch u-matic.

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